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ABSTRACT

Present systems for the apportionment of grants from the state or federal level to local public school districts are based primarily on measures of district wealth as modified by weightings for the characteristics of the student population. Until recently little attention has been given to differences among districts in the costs of providing educational services. The application of hedonic wage theory to this field of study is based on the assumption that it is not enough to assess differences in educational costs by considering cross-district variations in salaries paid personnel in similar positions. A measure of the attractiveness of the districts and of the positions, in nonmonetary terms, must be added to or subtracted from the salaries through application of a formula such as the hedonic wage index. In addition, characteristics making employees attractive to employers may result in different pay rates. Discussions of a mathematical model for applying the hedonic theory to school personnel, of effects of imperfections in the market on the model's accuracy, and of how the model can be used to estimate costs of school personnel for purposes of cross-district comparison are presented in this report. (Author/PGD)

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## Institute for Research on Educational Finance and Governance

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# THE HEDONIC WAGE TECHNIQUE AS A TOOL FOR ESTIMATING THE COSTS OF SCHOOL PERSONNEL: A THEORETICAL EXPOSITION WITH IMPLICATIONS FOR EMPIRICAL ANALYSIS

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September 1979

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# THE HEDONIC WAGE TECHNIQUE AS A TOOL FOR ESTIMATING THE COSTS OF SCHOOL PERSONNEL: A THEORETICAL EXPOSITION WITH IMPLICATIONS FOR EMPIRICAL ANALYSIS


## Abstract

In recent years some educational policy makers and analysts have argued that efforts to improve the equity of school finance should not be limited to improving the distribution of nominal differences in school spending, but rather should be directed toward improving the distribution of "real" educational services. To accomplish this goal, it will be necessary to construct an index of education cost differences that may be used to adjust the distribution of intergovernmental grants. Although there are a number of factors which contribute to the variations in educational costs, most of the previous research has focused attention on factors affecting the variations in the costs of school personnel, and particularly teachers. Since the focus of these previous studies is primarily empirical, not enough attention has been devoted to developing the theoretical foundation for the analysis of the variations in personnel salaries and costs. It is the purpose of this paper to digress from the empirical research to outline more systematically than has been done previously the theoretical framework for this line of research and to begin to address a number of important conceptual issues that arise in the conduct of the empirical work. The hedonic wage technique is the basic theoretical construct that has been adapted for the analysis of the costs of school personnel.



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## Introduction

Present systems for the distribution of intergovernmental grants from the state or federal level to local public school districts are based primarily on factors reflecting the nominal differences in local wealth and/or differences in pupil composition with respect to certain need characteristics such as mental or physical handicaps or cultural disadvantages.[1] Until recently little systematic attention had been given to the differences in the costs of educational services across local school districts and the possible ways of incorporating these cost differences into funding formulas which determine the level of intergovernmental grants. The state of Florida has taken the lead in explicit recognition of cost differences by constructing estimates of the cost of living, as a proxy for the cost of education, across local school districts and uses this index to adjust the distribution of state aid to schools. The fundamental difficulty with this approach is that cost of living and cost of education, while related to one another, are not the same thing. The cost of living in a particular school district is but one component in the location and work decisions which affect the supply, and hence the salaries, of school personnel. Moreover, the goods and services that are included in a cost of living index are not necessarily the same goods and services, nor are they consumed in the same proportions, as those included in school district budgets.

As an alternative to the cost of living approach, direct measures of the cost of education have been studied and are being considered in five states.[2] Although there are a number of factors which contribute to the variations in educational costs, most of the previous work has focused attention on factors affecting the variation in the costs of school personnel, and particularly teachers, since they consume such a large proportion of school district budgets.[3] Since the focus of these previous studies was primarily empirical, not enough attention has been devoted to developing the theoretical foundation for the analysis of the variations in personnel salaries and costs. It is the purpose of this paper to digress from these empirical studies to outline more systematically than has been done previously the theoretical framework for this line of research and to begin to address a number of important conceptual issues that arise in the conduct of the empirical

work. The theoretical framework proposed in this paper is actually more general than its application to schools and could easily be extended to assessment of personnel cost differentials in other public enterprises at the local, state, or federal level.

To accomplish this task, this paper has been organized as follows: Section I provides a formal statement of the problem and its relation to hedonic wage theory which forms the basis for the model presented in Section II. Section II focuses on the specification of the theoretical model of supply and demand for school personnel and the determination of the equilibrium levels of employment and wages. The model explicitly treats the micro aspects of the employment transaction by emphasizing the individual employee as the unit of analysis and by recognizing the potential for matching personal characteristics to the requirements and nature of alternative job assignments. Section III examines some of the modifications of the model along with the implications for empirical analysis and interpretation of results, related to the existence of lockstep salary schedules, differences in market structure, collective bargaining, market disequilibrium, and tenure and seniority rules. Section IV addresses some of the problems of index number construction and the implications of the theoretical model for the development of cost indices for school personnel. The final section summarizes the paper, suggests some lines of further research, and offers some concluding remarks on the role of opportunity cost measures and the use of fiscal and/or preference variables in the analysis of personnel costs.

## I. Statement of the Problem and the Relevance of Hedonic Wage Theory

Economists have long recognized that there is a systematic relationship between wages paid to labor and some set of personal and job characteristics. The advent of high speed computers and recent increases in the availability of detailed data sets containing information on personal and job characteristics of individuals has intensified research activity on the causes of variations in wages and salaries. The basic notion underlying this work on differential rates of pay is that individuals care both about the quality of their work environment as well as the pecuniary rewards associated with particular employment alternatives, and that they will seek to attain the

greatest possible personal satisfaction by selecting a job with the appropriate combination of pecuniary and nonpecuniary rewards. Similarly, employers are not indifferent as to the characteristics of the individuals to whom they offer particular jobs. The result of these simultaneous choices is the matching of individual employees with employers. It is the result of this matching process itself that reveals implicitly the differential rates of pay associated with the attributes of individual employees and the working conditions offered by employers.[4] More formally, it is the supply of, and demand for, individuals with certain personal attributes to any particular kind of job assignment that determines the equilibrium wages of labor as well as the implicit market prices attached to the personal and job characteristics.

The implicit relationship observed between wages and the personal and job characteristics of individuals is referred to as a hedonic wage index. The word hedonic literally refers to the physical and psychic pleasures that one can derive from engaging in certain activities. In the context of labor markets, the word hedonic refers to the satisfactions or utility derived by employees from the characteristics of the work place and the profits or the perceived productive value derived by employers from the characteristics of the employees they assign to certain jobs. The hedonic wage index permits one to decompose the variation in the wages paid to labor into the dollar values attached to each unit of the personal and work place characteristics. For example, one could determine how much more an employer would have to pay in the market to attract individuals with greater verbal proficiencies or greater physical strength to a particular kind of job, or how much less at the margin an employer would have to pay to attract workers to a job in air conditioned office space or to a job with a greater probability of bodily injury attached to it.[5]

Turning attention to markets for school personnel, hedonic wage theory suggests that in estimating the variations in the costs of school personnel, one cannot simply look to the differences in actual salaries paid across local school districts. Because of the differences in the attractiveness of local districts or the regions in which they are located, different salary levels will

be required to attract the kinds (or "qualities") of personnel necessary to provide similar levels of educational services across districts. For the purpose of identifying cost differences, it is essential to decompose salary variations into endogenous and exogenous components from the viewpoint of the district. The endogenous components of salary variation reflect the conscious choices of school decision makers in terms of the characteristics of the personnel employed and the attributes of the jobs to which they are assigned. It is the exogenous components of salary variation that underlie the estimates of differential personnel costs; that is, those elements of salary variation which are essentially outside the local control of the district decision makers.

To clarify this argument a bit, consider for a moment which elements of the employment transaction are actually controlled by local school officials. As a school decision maker, one can control not only the number of teachers employed, but also specifically which teachers, in terms of some set of personal characteristics, are employed out of any pool of willing applicants. Moreover, within certain limitations, school district officials can control the salary schedule and other aspects of compensation and working conditions. What these decision makers do not control is the composition of the willing pool of applicants, with respect to their personal characteristics, that show up to offer their services for any specified salary schedule and working conditions. In essence, what they do not control is the willingness of individuals to <u>supply</u> their services at any given levels of monetary and nonmonetary compensation.

Given this context, one can observe the patterns of salaries being paid individual school personnel across local school districts in relation to the particular personal, job, and locational characteristics. Hedonic wage theory offers both a conceptual framework for interpreting such relationships and a technique for disaggregating the relationship into the component parts. It allows one to determine the dollar weights implicitly placed by the market upon the characteristics of individual school personnel and the attributes of the jobs to which they are assigned and the work place in which they are located. Section II is devoted to a formal specification of the model.

## II. A Model of the Supply of, and Demand for, School Personnel[6]

(a) Supply. The individual is assumed to be seeking to attain the greatest possible personal satisfaction (perhaps along with that of his/her family) resulting from the appropriate selection of monetary and nonmonetary rewards offered by alternative employment opportunities (both inside and outside of education). The choice involves achieving a balance between the additional satisfaction received from spending the monetary rewards of work on private consumption (e.g., food, shelfter, and/or family recreation) versus sacrificing some of the monetary rewards to gain particular advantages in working conditions or location. Not all individuals possess the same preferences for working conditions or location. However, these differences in preferences are likely to be conditioned in part by personal background or experiences. For example, some teachers, perhaps because of their own socioeconomic or ethnic background, may be relatively more favorable to teaching culturally disadvantaged or minority pupils. Moreover, particular individuals may exhibit relatively strong preferences for geographic location because of the proximity of family or friends. Nevertheless, to some degree, the preferences for characteristics of the school work environment may be conditioned by the relatively common experiences that educators may have received in preparation for their careers.

More formally, it is assumed that the individual worker 'i' possesses a utility function defined over the monetary rewards from work and the characteristics of employment (denoted by the vector $Z_j$ for job j).[7] It is also assumed that workers possess complete information about available job opportunities. Further, the utility that one derives from any given set of job characteristics is assumed to be conditioned on a set of observed personal characteristics (denoted by the vector $C_i$) and some unobserved elements of individual tastes (denoted $e_i$). The real wage ($W_{ij}$) offered to a particular worker i for any job j is fixed according to the set of personal and job characteristics.

The utility function for individual i then may be specified in general as follows:

(1) $$U_i = U(W_{ij}, Z_j; C_i, e_i)$$

where the worker exercises choice over the job j which determines the $W_{ij}$ and $Z_j$ combination selected.

The optimization problem confronted by any individual may be broken down into two components following the analysis of Lancaster (1966). First, one can derive an efficiency frontier corresponding to the maximum wage offers made to a particular individual for the various combinations of job characteristics for all available jobs. Second, given the efficiency frontier which describes the trade-off between wages and job characteristics available to the worker, the individual may then select that bundle of wages and job characteristics that maximizes utility. Individuals with common wage offers will locate along the common efficiency frontier according to their tastes.

In equilibrium the shadow prices that are reflected in the slope of the efficiency frontier (i.e., the wage-job characteristics trade-off) are proportional to the marginal utilities of the respective job characteristics for the particular worker.[8] The solution to the individual worker's optimization problem is ultimately a function reflecting the willingness of the worker to supply labor services to a particular job j. Summing over all workers of type i, one can determine the total number (denoted by $T_{ij}$) of type i workers who will supply their services to job type j for any combination of wage offers and job characteristics. This supply function may be written as,

(2) $$T_{ij} = S_{ij}(W_i, Z_j; C_i, e_i), \text{ for all i and j}$$

where $S_{ij}(\ )$ is the supply function and $W_i$ is the vector of wage offers $[W_{ij}]$.[9]

(b) Demand. Local school decision makers are responsible for employing and organizing the various school inputs in order to provide the desired level of educational services at least cost. Naturally, some districts

will be more effective at this task than others. Selection and utilization of school personnel involves matching the personal abilities, qualifications and professional experiences of potential school employees to the varying needs of particular kinds of educational programs, job functions, and categories of pupils. Indeed, one could envision matching the personal characteristics of teachers to the particular needs of pupils in a specific school or classroom. This is not to imply that this matching of personal and job attributes is always successful (in terms of achieving optimality) or even a fully conscious process of decision making. There may be a certain amount of trial and error in the matching process and certain rigidities associated with the employment relationships in schools that make it difficult to accomplish such matching. Nevertheless, what is being asserted is that there is probably some tendency over time, whether through a conscious or unconscious process, for certain systematic patterns of choices to persist.

In order to attract the particular kinds of personnel desired, local school decision makers have a number of options available to them, in greater or lesser degrees, including adjustment of basic salary scales and/or the levels of fringe benefits (e.g., paid sick leave or district contributions to insurance plans) or improvement of working conditions either generally throughout the district or selectively for specific individuals exhibiting particularly valuable personal characteristics. It is important to recognize, however, that all of these options for increasing the attractiveness of employment opportunities in a given district occur within the context of certain fixed factors. For example, the numbers and composition of the pupils enrolled in a district, the attractiveness of the region in which the district is located (e.g., in terms of climate or crime rates) or the cost of living in the region are all factors beyond the control of local school decision makers. Hence, the ability of local school officials to attract certain kinds of individuals for particular jobs will depend in part upon the various attributes of the district and the region which must be taken as given. The task of the district is to offer the combination of the controllable monetary and nonmonetary rewards necessary to compensate the desired types of individuals for the uncontrollable nonpecuniary advantages or disadvantages implied by district and regional characteristics.

Presumably, the disadvantages of a particular job situation would elicit positive rewards, while the advantages would enable a district to obtain personnel with relatively lower monetary and nonmonetary rewards.

The behavioral model outline below is not intended to deal with the complexities associated with the objective assessment or measurement of the quality of services, but rather places the definition of educational quality in a market context. Educational quality, and the inputs of which it is composed, is implicitly defined by the behavior of local school decision makers in the market for school inputs. They reveal their perceptions of educational quality through their selection of school inputs and the assignment of particular school personnel to job situations.

Although the model is quite similar in structure to that specified for the determination of the supply of school personnel, there are a number of specific features that deserve special recognition. First, it is assumed that the contribution to educational quality of the individual depends upon a set of observed personal attributes ($C_i$) as well as a set of unobserved attributes (denoted by $v_i$). Second, in considering the decision to hire (or in the case of presently employed workers, to continue to employ) individual school personnel, school officials are making selections from among the entire pool of applicants and are therefore implicitly deciding on both the quantity and "quality" of its educational work force simultaneously.[10]

A third feature of the model is that the perceived productivity of any individual depends upon the attributes ($Z_j$) of the job to which he(she) is assigned. This aspect of the model has two dimensions. One is that productivity of the worker will depend upon the extent to which the decision makers have been successful in matching the skills of the worker to the requirements and responsibilities associated with the job assignment. For example, assigning an individual who has an undergraduate major in American literature to teach mathematics is likely to be less productive than assigning the same task to someone with training in mathematics. Along a second dimension, an individual is likely to put forth more effort in a job characterized

by pleasant surroundings or in an assignment whose requirements and responsibilities are consonant with his/her own personal preferences.[11]

A fourth feature of the model is the recognition that the characteristics and job assignments of other school personnel may affect the productivity of any given individual. For example, the productivity of any given teacher may be affected by which particular individuals are assigned to other teaching positions or the principalship of a school.

Finally, it is assumed that perceived quality of education is also affected by a set of other school inputs besides personnel as well as by a set of nonschool (or exogenously determined) inputs. Since there is likely to be a substantial amount of overlap between the job attributes ($Z_j$) and the sets of school and nonschool inputs, these latter sets of inputs will be represented in the model for purposes of simplicity by the vector of job characteristics.

Formally, one can specify the following general function to represent perceived quality of educational services.

$$(3) \qquad Q = Q(C, Z; v)$$

where $C = (C_1,\ldots,C_I)$, the vectors of characteristics of the applicant pool (individuals $i=1,\ldots,I$) and $Z = (Z_1,\ldots,Z_J)$ the vectors of job characteristics.[12]

The optimization problem for the district involves maximization of (3) subject to a budget constraint.[13] Focusing only on the decision to employ school personnel, one can break this optimization problem up into two components. One component involves determining the locus of the family of efficiency frontiers which reflect the least cost ways of assigning individuals from the pool of potential school personnel to available job assignments. The second component of the problem involves determining the optimal combination of personal and job characteristics along one of the efficiency frontiers based on the budget of the district.

In equilibrium for the district the shadow prices, that are reflected in the slope of the efficiency frontier, are proportional to the marginal productivities of the respective personal and job characteristics for all workers across all jobs. Given the budget of the school district, one can solve this set of equations for the optimal assignments of individuals to jobs as a function of the wages and characteristics (observed and unobserved) of both the individual workers and all other workers who might affect his/her productivity as well as of the job characteristics. The market demand curve for type i school personnel is obtained by summing across all type i personnel employed across all school districts and may be expressed as follows.[14]

$$T_{ij} = D_{ij}(W, C, Z_j, v) \text{ for all i and j,} \tag{4}$$

where $W = (W_1,\ldots,W_I)$, the vector of wage offers facing all workers for all jobs; $v = (v_1,\ldots,v_I)$, the vector of unobserved characteristics of all workers; and $D_{ij}(\ )$ is the market demand function.

(c) Determination of the equilibrium wages and employment levels. Market equilibrium levels of wages and employment are determined as in the standard case by equating the levels of supply and demand (i.e., $S_{ij}(\ ) = D_{ij}(\ )$) as specified in equations (2) and (4) above and solving simultaneously for the $W_{ij}$ which in turn may be used to determine the $T_{ij}$. Solving this set of equations, one obtains the following reduced form equations for the equilibrium levels of wages and employment.

$$W_{ij} = F(C, Z_j, u) \text{ for all i and j,} \tag{5}$$

$$T_{ij} = G(C, Z_j, u) \text{ for all i and j,} \tag{6}$$

where $u = (e_i, v)$. To make the empirical analysis tractable, one may find it necessary to simplify further by assuming the productivity of the individual school personnel is independent of other school personnel. Although this assumption may not hold strictly in reality, this simplification might not be too great a distortion given the considerable autonomy with which

educational personnel (particular teachers) operate in the school environment. This simplification reduces the data requirements necessary to implement the model since equations (5) and (6) may now be written including only those characteristics of the individual i in each case. One may write,

(7) $$W_{ij} = F(C_i, Z_j, u_i) \text{ for all i and j,}$$

(8) $$T_{ij} = G(C_i, Z_j, u_i) \text{ for all i and j,}$$

where $u_i = (e_i, v_i)$.

Equation (7) is the hedonic wage relation for school personnel and reflects the equilibrium levels of the implicit prices for personal and job attributes faced by districts in the markets for school personnel. It is derived from the efficiency frontiers confronting workers on the supply side and school districts on the demand side of the market. In equilibrium these two efficiency frontiers are coincident and equation (7) is the equilibrium frontier. This hedonic wage relation is the envelope of all of the indifference curves (reflecting the trade-offs between wages and job characteristics) for individual workers and the iso-quality curves for school districts. The points on this hedonic wage relation consist of the location in wage characteristics space selected by the various workers and school districts.

Rosen (1974) has shown that given the assumption that bundles of characteristics of commodities cannot be untied (i.e., that certain types of arbitrage are not permitted by the market) will lead to the result that the hedonic wage equation will not, in general, be linear. Drawing on an example analogous to that offered by Rosen, let us assume that years of experience is the only dimension along which one can differentiate between teachers. It is not likely that a teacher with twenty years of experience will be "worth" twice as much as a teacher with ten years of experience, nor is it likely that a teacher with fifteen years of experience is worth the same as one half-time teacher with ten years plus one half-time teacher

with twenty years experience. Therefore, the wage function is not likely to be a linear function of years of experience.[15] Note also that since equation (7) is a reduced form equation, it may be estimated by ordinary least squares techniques.

## III. Imperfections in the Market and Their Implications for the Model

The model described in Section II makes some simplifying assumptions regarding a number of aspects of the markets for school personnel. It provides no explicit recognition of the existence of the lockstep salary schedules that appear to characterize the system of compensation of school personnel. The model also assumes a perfectly competitive market structure, ignores the effects of collective bargaining, and assumes that the market to be studied is in equilibrium. These issues raise important questions as to the viability of the model for analyzing wage variations for school personnel and therefore must be addressed to determine whether the model can be adapted to these alternative assumptions prior to application of the model to empirical analysis. Each of these issues is addressed in turn below.

(a) The imposition of lockstep salary schedules. Lockstep salary schedules have existed for years in public education and provide a framework within which the salaries paid to individual school personnel are completely determined by some specific subset of personal and job assignment characteristics. Traditionally, teachers' salary schedules are composed of a base wage (denoted $w_0$) plus a set of salary increments (denoted by the vector 'a') for some subset of personal characteristics $C_i^{(1)}$ for $C_i$. The two most prominent personal characteristics recognized by school personnel salary schedules are years of experience in the district (as opposed to total years of experience) and the level of educational preparation (e.g., as reflected by such things as graduate hours of college credit earned, degree level, or types of professional certification). In addition, the base wage and/or the salary increments may be augmented by additional remuneration which is tied to a specific set of job responsibilities which may include anything from extra pay for coaching or coordination of extra

curricular activities to a complete shift in the salary schedule corresponding to a different job title (e.g., teacher, supervisor, principal, or superintendent). Let $Z_j^{(1)}$ be the vector representing the subset of job characteristics ($Z_j$) for which additional remuneration is explicitly provided to school personnel through the salary schedule, and let $b_0$ and $b_1$ represent the corresponding shift in the base wage and salary increments related to these job characteristics. Formally, the salary schedule may be written in the following simple linear form (which in fact is fairly representative of the actual observed structure of school salary schedules).

$$W_{ij} = w_0 + b_0 Z_j^{(1)} + (a + b_1 Z_j^{(1)}) C_i^{(1)}. \tag{9}$$

The important question is how does this salary schedule affect school district behavior and ultimately the hedonic wage relation specified in equation (7). To answer this question it is important to recognize that the parameters ($w_0$, a, $b_0$, and $b_1$) of the salary schedule itself as well as which characteristics are recognized (i.e, are included in $C^{(1)}$ and $Z_i^{(1)}$) are determined at the local level by school district decision makers (or in a growing number of cases jointly with teachers unions through collective bargaining). That is, the parameters are not exogenous to the district. However, this salary schedule does serve to restrict the nature of salary differentials paid within any given district. School personnel with identical values for the subset of characteristics $C_i^{(1)}$ and assigned to jobs with identical responsibilities as defined strictly by $Z_j^{(1)}$ receive identical salaries within any particular district, no matter what other valued personal attributes they may possess or what other job attributes may be associated with their assignment.[16]

The major effect of the imposition of the lockstep salary schedule is to reduce the flexibility of the school district in its employment decisions by placing limitations on the district's ability to use monetary forms of compensation to attract the desired types of personnel. The salary schedule has the affect of placing working conditions, and in particular those not recognized explicitly in the salary schedule, in a supreme position as a

form of compensation for valued personal attributes or behavior. For example, a principal desiring to retain a particular individual on his/her staff may tend to provide a more favorable classroom assignment perhaps in terms of class size or the composition of pupils with regard to learning or behavioral problems. However, because these working conditions have only a certain limited market value (as reflected by the implicit prices estimated in the hedonic wage relation), it may not always be possible to provide the level of working conditions necessary to compensate individuals for desired personal attributes other than those explicitly recognized in salary schedules. That is, given a salary schedule defined primarily by years of experience and educational preparation, there are limits in the extent to which such things as smaller class size or more favorable compositions of pupils can be used to attract teachers who exhibit exceptional skills.

(b) Variation in market structure. The case of competitive markets for school personnel has been outlined in Section II. However, there are at least three questions related to deviations from the competitive assumption that have to be answered regarding the estimation and interpretation of hedonic wage relations. How do we interpret the observed hedonic wage relation under the assumption that districts do exert some monopsony power in the market? Are deviations from the competitive assumption a serious consideration for empirical work on school personnel labor markets? And, how might we treat competition in the empirical analysis?

Consider first the case where there is a single buyer (i.e., the case of pure monopsony) of labor services in the market for school personnel. The model of labor supply specified in Section II is basically unaffected. What is altered, however, is the conceptualization of the demand side of the market. The major difference is that the school district confronts the entire market for each type (defined over all values of i) of school personnel. If the school district, as a monopsonist, behaves as a maximizer of perceived quality as suggested by the model in Section II-b, it will still locate along the supply curve for the school personnel. As in

the usual monopsony case, the school district will face a higher marginal cost of personnel than the competitive district and will, therefore, hire fewer workers at a lower equilibrium wage. The observed hedonic wage relation would, in this case, reflect the supply schedule for school personnel.[17]

But given this analysis of the monopsony case, one must ask whether the assumption of competitive markets for school personnel is a poor representation of reality. The answer is that in a large proportion of the cases, it is likely that the competitive assumption is viable. First, the vast majority of school personnel are employed in metropolitan areas which in most regions of the country (with the notable exception of the Southeast) support a fairly high density of independently operated school districts that compete for labor services.[18] Second, in defining the bounds of the relevant labor market, one must recognize that not only do school personnel, and particularly teachers, possess other kinds of labor market opportunities (e.g., in private education, business, or government), but also it requires little, if any, additional training in most states for anyone with a bachelor's degree to enter, at least on a probationary basis, the market for teachers. Even school districts in remote areas must compete to some degree with alternative labor market opportunities, although perhaps far fewer than in more urbanized areas. The implication is that school districts find themselves competing in a market much larger in scope than that defined by the boundaries of the teaching profession. More formally, this suggests that the vectors of alternative wages ($W_i$) and the sets of job characteristics confronting individual workers includes a broader range of alternatives than those defined by the markets for school personnel.

Finally, regarding the treatment of competition in the empirical analysis, one must begin with the recognition that monopsony power, or the impediments to competitive behavior, exist to some degree throughout labor markets primarily because of the costs of information and mobility. In this sense, one can deal with monopsony or, alternatively, competition in matters of degree rather than in the absolute. This being the case, one

might consider the inclusion in the empirical analysis measures of the degree of competition in the market such as the number (or density) of school districts operating in the region (higher densities of districts being associated with greater competition), the concentration of market power (i.e., relative sizes) of school districts, and the size of the region (e.g., population as a proxy for other labor market opportunities).[19]

(c) The impact of collective bargaining. Over the last decade, collective bargaining for public school employees has become more prevalent across the country and has tended to reduce the flexibility of district decision makers in adjusting wage scales and working conditions for school personnel (e.g., see Chambers, [1977]). Nevertheless, school decision makers are able to make certain adjustments at the margin to union gains in wages and working conditions. With wage scales above what they would have been in the absence of bargaining, districts will attempt to adjust the characteristics of the personnel they employ and the jobs to which they are assigned commensurate with the higher rates of pay.[20] However, this distortion of school district employment decisions will either result in no change or a reduction in the perceived quality of school services.[21] To the extent that districts are unable to adjust personal and job characteristics, one will observe some additional impact on wages independent of the systematic variations in selection and assignment of personnel. But it is likely that the primary long-run effect of bargaining will involve adjustment of recruitment and assignment policies and practices.

With regard to empirical analysis of wage differentials, there is a potential confounding between the effects of collective bargaining and competitiveness of the labor market. It is a standard result of the traditional monopsony model, that unions will tend to be in a stronger bargaining position in a monopsonistic as opposed to a competitive labor market (even in the case where the union negotiates with all of the competitors) due to the lack of disemployment effects of a wage increase (at least until

the wage rate is set at or above the level of the marginal revenue product of labor to the firm).[22] Suppose for a moment that there are unmeasured bargaining effects and that the wage differentials due to bargaining were not entirely uniform across the state because of the differences in market structure across regions of the state: that is, wage gains are higher in the monopsonistic markets. If bargaining is a universal phenomenon, then the relationship between wages of school personnel and the competitiveness of the labor market may tend to be biased downward, ceteris paribus, since the measure of competition is in part picking up the relatively stronger bargaining power of the union in the monopsonistic market. If this downward bias exists, then one might hypothesize that measures of degree of competitiveness in the market will tend to appear (incorrectly) stronger in states where less bargaining occurs and the effects of competitiveness will appear to decline over time as bargaining becomes more universal. Moreover, this trend is perhaps more likely to be revealed in non-metropolitan regions where monopsony power of school districts would, if anywhere, tend to be stronger.

(d) Disequilibrium in the market for teachers. Even casual observation of the market for teachers reveals the evidence of an excess supply. At the current salaries being offered teachers, more individuals are willing to supply their services than districts are willing to hire. The question arises, "What are the implications of the surplus within the context of the hedonic wage model?"

Clearly, the existence of excess supply (or demand) for different "types" of labor will tend to affect the observed implicit prices of personal and job characteristics. Unfortunately, the hedonic wage equation does not permit one to determine whether the estimated coefficient for any particular characteristic reflects an equilibrium or disequilibrium price. One can always argue, for example, that an "incorrect" sign on a coefficient reported for any given job characteristic reflects some omitted personal characteristics which affect productivity.

Despite this rather pessimistic view, some further analysis is possible. One possible way for assessing the impact of the surplus on the implicit prices of personal and job characteristics is to examine the different prices observed for different cohorts of teachers. In particular, the effects of the surplus are likely to be felt most immediately among those teachers currently seeking employment in the market. That is, competition among those teachers seeking employment in the current market is likely to drive down both the implicit price of valued teacher attributes and the compensating differentials required for disadvantageous working conditions. On the other hand, for those teachers who were hired during earlier periods not characterized by excess supply and whose jobs are protected by tenure and seniority restrictions, one might expect to observe relatively higher marginal prices for valued personal attributes or disadvantageous working conditions. Formally, this result may be expressed as follows using the hedonic wage relation (7).

$$(10) \qquad \frac{\partial F_N}{\partial C_k} < \frac{\partial F_O}{\partial D_k} \quad \text{and} \quad \frac{\partial F_N}{\partial Z_j} < \frac{\partial F_O}{\partial Z_j}$$

where $F_N$ and $F_O$ refer to the hedonic wage relations estimated for the newer (N) and older (O) cohorts of teachers, respectively; $C_k$ is a valued teacher attribute; and $Z_j$ is a disadvantageous job characteristic. The implication of this analysis simply stated is that adjustment of the implicit prices to equilibrium levels will tend to occur more quickly among newer than older cohorts of teachers.

(e) Tenure and seniority rules. Both school decision makers and individual school personnel operate within the context of certain rigidities and immobilities that prevent immediate adjustment to changes in the market conditions or personal circumstances. For the most part these rigidities and immobilities arise out of the tenure and seniority rules usually specified in state law or union contracts. These rules often place a fairly substantial burden of proof on a school district to "show cause" for termination of a personnel contract and where dismissal is warranted by declining

enrollments or reductions in funding it must usually be based on inverse order of seniority.[23] From the standpoint of the individual employee, tenure is generally not transferrable across districts, even within the same state, and very often districts will allow only partial credit for the purposes of salary determination for experience gained in other school districts. Both of these factors serve to reduce the incentives for mobility among school employees.

However, while both district decision makers and school employees operate under these immobilities, it is important to recognize that both are cognizant at the outset of the existence of these rigidities in the system and are likely to try to adjust their behavior to account for them. Districts recognize that teachers are not employed on a year to year basis and that any particular teacher is likely to remain in a district for a number of years. Indeed, it is not at all unlikely that districts perceive systematic patterns of mobility related to certain personal characteristics of school employees and adjust their hiring policies or decisions accordingly. Therefore, to some extent the district's perception of the value of any certain employee is conditioned by the expected length of time that employee will remain with the district. Similarly, potential school employees also recognize that they are generally committing themselves to provide services to a particular district over a period of years, and they acquire in exchange a stream of income, which is based on the existing salary structure and the factors affecting future changes in the schedule during the expected period of stay in the district, as well as on the set of working conditions which characterizes the district.

The point of this analysis is that even though the market for public school personnel is characterized by a certain amount of rigidity, adjustments may be made in the long run on both sides of the market to these rigidities. In circumstances of equilibrium, then, the hedonic wage model may not significantly distort reality. Unfortunately, it is during times of sudden and unanticipated changes in circumstances (e.g., changes in enrollment levels or program funding) that these rigidities are likely to reduce the speed with which both sides of the market adjust and will therefore exacerbate the disequilibrium.

## IV. Using the Hedonic Wage Index to Estimate the Costs of School Personnel

The ultimate goal of this analysis of hedonic wage indices for school personnel is to demonstrate how this technique might be used to estimate the variations in the costs of school personnel across local school districts. For the purpose of calculating an index of costs, one must isolate that component of the variation in personnel salaries that is outside the control of local school decision makers. Ideally, one would like to determine the variation in the costs to local decision makers of providing the same "quality" of educational services across school districts. There are two dimensions to these variations in the costs of school personnel. One dimension involves estimating, for any level of endogenously determined working conditions, the differences in salaries that different school districts must offer in order to obtain teachers (or other school personnel) capable of providing similar levels of educational services. A second dimension involves estimating the variations in costs associated with employing different kinds and combinations of school personnel necessary to meet the needs of various categories of pupils served by various educational programs (e.g., for handicapped or disadvantaged children). The first dimension involves estimating a "quality" adjusted price for school personnel, while the second dimension involves estimating the variation in costs associated with programmatic needs of various groups of pupils. Only the quality adjusted price or wage index is addressed in this paper.

Unfortunately, the calculation of an educational cost index involves an index number problem. Specifically, there is no universally accepted way to measure the quality of educational services, which must be held constant in order to calculate a "true" education cost index. However, ignoring differences in costs associated with different programmatic needs of various pupil populations (the second dimension of cost variation referred to above), one can calculate a fixed characteristics index as a first approximation to estimating a quality adjusted wage for school personnel. Clearly, such an index ignores the substitution possibilities across the personal characteristics that might result from a change in the relative costs. In fact, there are two factors operating to change the optimal choices of personal characteristics in response to relative price differences. These two factors

combine to make it difficult to determine the nature of the bias in the index. The first factor arises out of the substitution possibilities within the context of the perceived production technology. This is analogous to the problem that arises in the standard index number problem related to the measurement of utility (or educational quality in this case). The second factor, and one that does not arise in the standard index number problem, is that variation in the relative costs of the characteristics will in general alter the position and slope of the efficiency frontier. The difficulty is that to calculate the quality adjusted wage index for school personnel requires the selection of a set of standard (e.g., mean) values of the endogenous variables, and as Meullbauer (1974) has demonstrated formally and Lucas (1977) has illustrated graphically, the fixed characteristics index may over or underestimate the "true" differences in costs. Unlike the standard formulation of consumer theory, the Laspeyres and Paasche indices do not place boundaries on the calculation of the index.

To illustrate this index number problem, consider the diagram in Figure 1 which displays the relationship between teacher wages and a selected

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Insert Figure 1 about here

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personal characteristic. Let $P_1$ represent the equilibrium position for a school district which, given its efficiency frontier $E_1E_1$, selects teacher type i (personal characteristics $C_i$). Now consider a school district located in a different region of the state characterized by a set of "disadvantageous" locational attributes. This school district selects a teacher type i' along the efficiency frontier $E_2E_2$. If one were unable to account for the differences in the shadow prices of personal characteristics across different districts, then one would measure the necessary wage differential as the distance $P_1P_2$ which involves a parallel shift of the original efficiency frontier $E_1E_1$ to $E_1'E_1'$ such that the latter frontier was tangent to the iso-quality curve for the district located in the less preferred region. This also assumes that the two districts are identical in all respects except for the differences in locational attributes on supply. If

one were able to account for differences in the shadow prices (i.e., the slopes of the efficiency frontiers), then the cost differential would be measured by the distance $P_1P_2'$ which reflects the wage differential along the different efficiency frontier facing the second district, but does not reflect the substitution away from the personal characteristics which resulted from both the differences in the shape of the efficiency frontiers and the substitution possibilities in production (reflected by the curvature of the iso-quality curve).

There is one other theoretical consideration related to the treatment of market disequilibrium in the estimation of personnel cost differentials. One might argue that it is the equilibrium implicit price differences that are relevant to the determination of "true" variations in personnel costs. Clearly, the very long-run perspective would favor this position. In this case, the implicit price differentials obtained by analyzing the salary differentials of the newer cohorts of teachers may tend to be more reflective of equilibrium patterns (see the discussion in Section III-d). On the other hand, one could argue that the estimates of the hedonic wage relation obtained by including all teachers in the analysis reflect current circumstances confronted by school districts in the market for school personnel and, therefore, should serve as the basis for any estimates of the differential costs of services.

These theoretical issues aside, the practical consideration of how to calculate a personnel cost index still remains. The cost of any given category of school personnel is defined as that portion of the variation in personnel salaries that is exogenous to local school decision makers. Thus, a personnel cost index may be obtained by first dividing the set of explanatory variables in the hedonic wage relation into endogenous and exogenous components and then simulating the variations in personnel salaries that would exist if only the exogenous factors were permitted to vary. Since the model proposed in this paper describes the long run decisions of school personnel on the one hand and school decision makers on the other, the approach to dividing the explanatory variables into the endogenous and exogenous components which is most consistent with the model is one that is based on this long run perspective.

Given this long run perspective, virtually any personal or unique job assignment characteristic of a particular individual is within the control of school decision makers. Although there may be short run constraints on a district's ability to adjust staff characteristics, one can always postulate that over a long enough period of time school decision makers will be able change the composition of its staff in any way it chooses to do so. Moreover, even within a fairly short run period of time (e.g., from one semester or year to the next), school decision makers can make adjustments in the allocation of individual personnel among job assignments. In addition, certain characteristics of the work environment that are shared across more than a single assignment are also school inputs and as such are endogenous to district decision making. The factors that are exogenous to school district decision making are those that are immobile (i.e., location specific) and are substantially determined by the choices of other decision making units (e.g., other levels of government, families, local commerce) whose behavior is only insignificantly affected by school district decisions.

To clarify this argument a bit, consider some of the following examples of endogneous and exogenous explanatory variables. A teacher's education, experience and verbal ability, as well as his/her class size or the composition of the class with respect to ability or racial/ethnic background of the pupils, are all within the control of the district. In a district with more than one school, the composition of the pupils in the school with respect to ability and race/ethnic background is within the control of the district within the limits of the total size of the district and the overall composition. In fact, even the number of schools (and therefore average school size) in the district is within the control of the district in the long run. However, the total enrollment of the district or the composition of that enrollment with respect to pupil ability or race/ethnic background would seem to be exogenously determined. Moreover, the cost of living in the region or the district's location relative to urban centers or its climate would all be exogenously determined, location specific characteristics. Similarly, crime rates, which to some extent may be governed by decisions of the local police departments, are outside school district control.

Formally, a personnel cost index may be written using the hedonic wage relation F( ) in equation (7) as follows:

$$(11) \qquad \frac{W_k}{\bar{W}} = \frac{F(\bar{Y}, X_k)}{F(\bar{Y}, \bar{X})}$$

where k refers to the $k^{th}$ school district; Y refers to the personal characteristics vector C and the endogenous components of the job characteristics vector Z; X refers to the exogenous components of the job characteristics vector Z; and the bars over the variables refer to the standard of comparison which may be the average district in a region or a state.

## V. Summary and Concluding Remarks

The major purpose of this paper has been to outline in some detail a model that could serve as a foundation for the empirical estimation and interpretation of the patterns of variation in the salaries paid to school personnel across local school districts and to show how this analysis might be used to develop indices of personnel costs. The hedonic wage model proposed is based on the notion that individuals care about the quality of their work environment and that employers (school districts in this case) are not indifferent with respect to the personal characteristics of their employees. The model of demand not only explicitly recognizes that certain subsets of personal characteristics affect productivity, but also allows for the possible productive value of matching individuals' skills to job requirements and the differences in effort related to the quality of the work environment.

The result of this matching process between individuals and jobs is a reduced form equation, referred to as a hedonic wage index, which reflects the equilibrium relationship between wages and the personal and job characteristics. The relative value of each of these personal and job characteristics is implicitly revealed in the market by means of the choices of individuals among job alternatives and the choices of school districts among alternative workers.

The imposition of lockstep salary schedules on district decision making was shown basically to limit the range of options for attracting school personnel with valued attributes. It was also shown that under the assumption of monopsony the hedonic wage relation could be interpreted as the supply function. But more importantly, it was argued that the assumption of a competitive market for school personnel is likely to be viable due, first, to the relatively large number of districts commonly found in most (at least metropolitan) markets for school personnel and, second, to the fair amount of mobility that is possible between the education and non-education job markets which broadens the scope of enterprises competing for labor services. Collective bargaining was shown to reduce flexibility without really altering the interpretation of the hedonic wage index.

Although it was indicated that the hedonic wage index would not distinguish between equilibrium and disequilibrium estimates of the parameters, it was suggested that wage analysis among different cohorts of teachers, in particular the newly hired versus the relatively senior and tenured teachers, may provide some information on the directions of the effects of disequilibrium on the implicit price estimates. Moreover, it was argued that, while tenure and seniority rules tend to inhibit the ability of the market to adjust to short run disequilibrium, both district decision makers and individual workers attempt to account for these rules, and the accompanying market immobilities, in their employment decisions, and that given this long-run perspective, the hedonic wage model may be a reasonable approximation to reality.

The final section of the paper presents some of the theoretical problems with creating index numbers from the hedonic wage relation, but goes on to suggest an approach to estimate an index of personnel costs. Ultimately, these personnel cost indices may be combined with cost indices for other components of educational expenditures to develop an overall cost of education index which may be used to assess the effects of alternative school finance reforms directed toward the equalization of the distribution of educational resources across local school districts. Indeed, one of the important topics for further research on education cost differences involves

examining the properties and relationships between cost of education indices constructed using alternative methods for combining personnel and non-personnel component indices. For the most part previous empirical studies have constructed the overall cost of education index by using the quality adjust prices of school inputs to price out a "standard market basket" of school inputs. Other alternatives include econometric methods and variants of the "standard market basket" approach both of which are capable, under certain assumptions, of reflecting variations in education costs due not only to differences in (quality adjusted) input prices, but also to variations in programmatic needs of different groups of pupils and the scale of district operations.

Before concluding this paper there are two additional issues that deserve some attention: (a) the use of opportunity costs as a proxy for personnel cost differences and (b) the inclusion of certain fiscal or "preference" variables in the analysis of personnel costs.

(a) Use of opportunity costs. Based on the growing interest in adjusting for education cost differences and given the lack of data on detailed personal and job characteristics, it has been suggested by Frey (1973) that because of the importance of opportunity cost (as measured in his study by the wages of industrial nurses) as a determinant of the variation in teacher wages, one might use this relationship to proxy teacher cost differences. The underlying notion is a sound one and one that does have a basis in theory. However, there are a number of theoretical and empirical factors which limit the value of this approach. The question arises, "Which market or occupation should be used as the benchmark for teachers?" The issue of comparability becomes a paramount concern. The two markets being compared must reveal a good deal of similarity in order to ensure that the results of the analysis do not reflect irrelevant differences between the two.[24] As Hyman (1977) has suggested, educational requirements of teaching and the comparison occupation(s) must permit some mobility across occupations, the structures of the markets (i.e., degree of competitiveness) should be similar, and collective bargaining should exist to the same degree. Furthermore, given the differences in the elasticities of demands for

quantity and quality of labor between teaching and the alternative occupation(s), there is likely to be some variation in the quality of the alternative labor force relative to that of teachers across regions. Finally, the opportunity cost alone is not sufficient to capture some of the other possible factors that might affect the variations in the costs of teachers, since none of the characteristics of schools or districts are likely to affect the equilibrium wages in alternative occupations in the same way, if at all, that they affect teachers wages.

(b) The role of fiscal or preference variables. Although some authors (Brazer [1974], Brazer and Anderson [1975], Grubb and Hyman [1975], and Loatman [1977]) have included certain fiscal and background characteristics of the community to reflect district wealth and taste differences, one can see based on the model outlined in Section II of this paper that these variables play no direct role in the determination of equilibrium wages of teachers. The hedonic wage relation is a function only of the personal and job characteristics of the individual school personnel. While higher wealth and income districts are likely to pay higher teachers salaries, this effect acts indirectly through the demand for characteristics of school personnel. That is, wealthier districts set higher salary schedules or provide better working conditions overall in order to attract "better" teachers. Similar arguments can be made with respect to specific taste variables: they generally operate through differences in selection and assignment practices for school personnel, but have no direct affect within the context of the hedonic wage relation.

One could alternatively suggest that these fiscal or preference variables reflect working conditions and hence should be included in the wage regressions on this basis. However, it can be shown in most cases that many of these variables are likely to be proxies for, but not perfect correlates of, the actual working conditions they represent. Thus, to avoid confounding affects and the accompanying difficulties in determining the appropriate variables to include in estimating a personnel cost index, it would seem a more appropriate strategy to obtain the direct measures of the job characteristics whenever possible. For example, wealthier districts are likely to provide

better facilities or support services for teachers. Rather than proxy these affects with district wealth, it would be preferable and reduce ambiguity to use direct measures of support services (e.g., availability of teachers' aides or curriculum specialists) and facilities (e.g., age and condition of school buildings).

As a further example, one might hypothesize that teachers would prefer to teach children in the middle to upper ranges of socioeconomic status to children from lower socioeconomic status families. However, one has to question what it is about socioeconomic status that creates this preference. One might suspect that except in the most extreme circumstances, it would be difficult to distinguish a high from a low socioeconomic status child simply by looking at him/her. Rather, it is more likely that these children distinguish themselves to teachers according to their ability, motivation, or classroom behavior. Hence, it is the set of performances or behaviors that are likely to distinguish between the children rather than the socioeconomic status per se. Thus, although socioeconomic status might be a proxy for these behaviors, it would still be preferable to include direct measures of these attributes whenever possible to avoid the ambiguity that might arise from the possibility that socioeconomic status may be reflecting some other set of factors.

One further factor that should be noted is that the coefficients reported on the fiscal or socioeconomic status variables generally reveal positive relationships to salaries which is contrary to the interpretation that these factors reflect preferred working conditions. At best one could reason that these variables reflect omitted teacher attributes (valued by decision makers) and as well as preferred working conditions and that the effect of the omitted teacher attributes is relatively stronger. Under any circumstances such variables are open to considerable ambiguity of interpretation and direct measures of the relevant characteristics would always be preferred.

FOOTNOTES

[1]For the ranges of alternatives, the reader may refer to "School Finance at a Fourth Glance, May 1979," a chart prepared by the Education Finance Center of the Education Commission of the States, Denver, Colorado.

[2]A number of studies have been funded by various State Departments of Education or other state agencies as part of efforts to study school finance reform alternatives. These include studies in Missouri (Chambers, [1978a]), California (Chambers, [1978b]), and Texas (Augenblick and Adams, [1979]). Studies are also under way in New York (being conducted by Wayne Wendling of the Education Commission of the States) and in Florida (being conducted by Edgar Fresen of the Florida State Department of Education). Further work is also underway in California (being carried out by Chambers at Stanford University). Other studies of costs of education have focused on California (Grubb and Hyman, [1975]), Michigan (Brazer, [1974], and Brazer and Anderson, [1975]), and Florida (Kenney, Denslow, and Goffman, [1975]).

[3]Salaries of instructional personnel alone account for almost 60 percent of the average expenditures for public elementary secondary schools in the United States (see pages 304 and 307 of the Standard Education Almanac, 1976-77, ninth edition published by Marguis Academic Media).

[4]For an excellent comprehensive discussion of the theoretical foundations for this type of analysis, see Lucas (1972).

[5]See Lucas (1977) for empirical estimates of the impact of various types of job characteristics on individual wage differentials.

[6]The formal presentation of the models of supply and demand and of market equilibrium draws heavily on the definitive analysis presented in Lucas (1972).

[7]The elements of $Z_j$ in this context will be assumed to include both job assignment characteristics as well as locational attributes of the place of employment. The term "job characteristics" will be used through this paper to refer to both of these elements.

[8]This equilibrium is approximated even in the "lumpy-commodity" case (as Lucas, 1972) refers to it where the consumption possibility (efficiency) frontier consists only of a series of points in characteristics space and does not include the facets connecting them. This case becomes relevant when the consumer is typically observed to purchase only one of any particular good (e.g., cars or jobs) on the market and raises some concern as to whether or not the tangency condition that describes equilibrium choice

will be satisfied. Lucas points out that as long as the commodities are sufficiently dense in the neighborhood of choice along the efficiency frontier, then the tangency condition may be nearly approximated. "Further, we know that, from the point of view of trying to 'sell' occupations, there is an incentive for employers to introduce occupations in the neighborhood of existing choices, (although the difficulties of introducing such a job may outweigh this)." (pp. 74-75).

[9]To avoid the writing of all job characteristics for all job assignments in equation (2), one can employ McFadden's axiom on the irrelevance of alternative sets which applies in the context of nonreplicated experiments. See McFadden (1974), p. 110, axiom 3.

[10]Given the tenure and seniority rules, one might question whether the "continue to employ" portion of the statement in parentheses is relevant to schools. This issue is taken up subsequently in Section III.

[11]See Levin (1978) for a more comprehensive treatment of the relation between teacher effort and a variety of environmental determinants.

[12]Note that it is likely that some job types (j) may not exist in a particular district. In this case, it is implicitly assumed that these elements are dropped from the vector Z.

[13]Actually, districts in many states have budgetary discretion, but for the purpose at hand it adds nothing to the problem to incorporate budget determination into the model.

[14]See the explanation in note 9 above.

[15]The example used by Rosen is in terms of the length of a car. He suggests,

> (I)n terms of one characteristic, two 6-foot cars are not equivalent to one 12 feet in length, since they cannot be driven simultaneously...; while a 12-foot car for half a year and a 6-foot car for the other half is not the same as 9 feet all year round....Similarly, assume sellers cannot repackage existing products in this manner or do not find it economical to do so, as might not be the case with perfect rental markets and zero transactions and reassembly costs (p. 38).

[16]It should be noted in passing that salary schedules are not unique to public school districts or for that matter to the public sector in general.

Many private firms specify salary schedules for employees, although they may tend to be somewhat less restrictive in form. Union wage scales might well be an example. The point is that public schools or agencies are not the only employers seeking ways of circumventing the effects of salary schedules on employment decisions in order to enhance their ability to attract the most productive workers.

[17]See the similar discussion on product market monopoly in Lucas (1972), Chapter II.

[18]Many states in the South have county-wide school districts. However, in most other sections of the country, there are a fairly large number of school districts per county in metropolitan areas.

[19]See Nutter and Moore (1976) for the possible link between numbers of firms in a market and the degree of competitive behavior.

[20]See Borjas (1979) for evidence of a positive association between union membership and job satisfaction. This relationship may be to some extent reflecting the worsening of working conditions that employers might impose on employees in response to the higher rates of pay negotiated by the union.

[21]This results from the fact that any additional constraint imposed on an optimization problem must result in a negative or no change in the value of the objective function.

[22]This is a standard result of microeconomic theory of the firm in labor markets characterized by monopsony. For example, see Ferguson and Maurice (1974), pp. 370-72.

[23]"Cause" for termination generally includes such things as incompetence, immoral behavior, noncompliance with school laws, insubordination, neglect of duty or misconduct in office, physical or mental disability or conduct unbecoming a teacher (unprofessional conduct). For a complete listing of causes and the frequency of appearance in state laws governing tenure, see "Statutory Requirements of Teacher Contract Laws: A Comparison for the 50 States' Continuing Contract and Teacher Tenure Laws, December 1976 prepared by Kris Van Gorkom, Senate Research Center, Washington State Senate.

[24]Hyman (1977) presents an excellent and comprehensive review of the problems with the opportunity cost method in his dissertation.

## BIBLIOGRAPHY

Antos, Joseph R. & Rosen, Sherwin. "Discrimination in the Market for Public School Teachers." Journal of Econometrics 3:3 (1975), 123-50.

Ashenfelter, O. "The Effect of Unionization on Wages in the Public Sector." Industrial and Labor Relations Review 24(2) (1971), 191-02.

Augenblick, John & Adams, Kathleen. "An Analysis of the Impact of Changes in the Funding of Elementary/Secondary Education in Texas: 1974/75 to 1977/78." Prepared for the Texas Legislative Commission on Public School Finance, April 1979. Education Finance Center, Education Commission of the States, Denver, Colorado.

Averch, Harvey A. et al. How Effective is Schooling? A Critical Review of Research. A Rand Educational Policy Study. (Englewood Cliffs, N.J.: Educational Technology Publications, 1974).

Baird, R. N. & Landon, J. H. "The Effects of Collective Bargaining on the Public School Teachers' Salaries." Industrial and Labor Relations Review 25(3) (1972), 410-16.

Barro, S. M. "The Impact of Intergovernmental Aid on Public School Spending." Unpublished doctoral dissertation, Department of Economics, Stanford University, (1974).

Borjas, George J. "Job Satisfaction, Wages, and Unions." The Journal of Human Resources XIV(1) (Winter 1979), 21-40.

Brazer, Harvey E. "Adjusting for Differences Among School Districts in the Costs of Educational Inputs: A Feasibility Report." In Selected Papers in School Finance 1974. Washington: Office of Education, U.S. Department of Health, Education, and Welfare, (1974).

Brazer, Harvey E. & Anderson, Ann P. "A Cost Adjustment Index for Michigan School Districts." In Selected Papers in School Finance 1975. Washington: Office of Education, U.S. Department of Health, Education, and Welfare, (1975).

Chambers, Jay G. "An Analysis of Resource Allocation in Public School Districts." Public Finance Quarterly (April 1978), 131-59.

Chambers, Jay G. "The Impact of Bargaining on the Earnings of Teachers: A Report on California and Missouri." Paper presented at the U.K.-U.S. Conference on Teacher Markets, University of Chicago, December 1976.

Chambers, Jay G. "The Impact of Collective Bargaining for Teachers on Resource Allocation in Public School Districts." Journal of Urban Economics 4 (July 1977), 324-29.

Chambers, Jay G. "The Impact of Collective Negotiations for Teachers on Resource Allocation in Public School Districts." Unpublished doctoral dissertation, Department of Economics, Stanford University, (1975).

Chambers, Jay G. "School District Behavior, Markets for Educational Resources and the Implications for Public Policy: A Survey." In Economic Contributions to Education, ed. Douglas Windham. (Washington, DC: National Academy of Education, 1979).

Crain, W. Mark & Zardkoohi, Asghar. "A Test of the Property-Rights Theory of the Firm: Water Utilities in the United States." The Journal of Law and Economics XXI(2) (October 1978), 395-08.

Ehrenberg, R. G. "The Demand for State and Local Government Employees." American Economic Review 63 (1973), 366-79.

Ehrenberg, R. G. "A Model of Public Sector Wage Determination." Journal of Urban Economics 2 (1975), 223-45.

Ellickson, Byran, with Fishman, Barry, & Morrison, Peter A. Economic Analysis of Urban Housing Markets: A New Approach. The Rand Corporation, R-2024-NSF, (July 1977).

Ferguson, C. E. & Maurice, S. Charles. Economic Analysis, Richard D. Irwin, Inc. (revised edition 1974).

Fox, James N. "Cost-of-Living Adjustments: Right Intent, Wrong Technique." Phi Delta Kappan 56 (April 1975), 548-50.

Frey, D. E. "Wage Determination in Public Schools and the Effects of Unionization." In Labor in the Non-Profit and Public Sectors (D. S. Hammermesh, ed.), (Princeton, N.J.: Princeton University Press, 1975).

Griliches, Zvi. "Hedonic Price Index for Automobiles: An Econometric Analysis of Quality Change." In Price Indexes and Quality Change: Studies in New Methods of Measurement, ed. Zvi Griliches. (Cambridge, Mass.: Harvard University Press, 1971).

Griliches, Zvi. "Hedonic Price Indexes Revisited." In Price Indexes and Quality Change: Studies in New Methods of Measurement, ed. Zvi Griliches. (Cambridge, Mass.: Harvard University Press, 1971).

Griliches, Zvi. "Notes on the Role of Education in Production Functions." In W. Lee Hansen, ed., Education, Income and Human Capital, National Bureau of Economic Research, Studies in Income and Wealth 35 (New York, N.Y., 1970).

Grubb, W. Norton & Hyman, James. "Constructing Teacher Cost Indices: Methodological Explorations with California Unified School Districts." In Selected Papers in School Finance 1975. Washington: Office of Education, U.S. Department of Health, Education, and Welfare, (1975).

Hall, W. C. & Carroll, N. E. "The Effect of Teachers' Organizations on Salaries and Class Size." Industrial and Labor Relations Review 26(2) (1973), 834-41.

Hyman, James B. "Cost of Education Indices; Alternative Methods, Issues and Answers." Unpublished doctoral dissertation, Stanford University, (1977).

Johnson, Gary P. "Cost-of-Education Indices: The State of the Art and Implications for Indiana School Finance Reform." State of Indiana, State Department of Public Instruction, Indianapolis, Indiana, (March 1978).

Kasper, H. "On the Effects of Collective Bargaining on Resource Allocation in Public Schools." Economic Business Bulletin 23(3), (1971), 1-9.

Kasper, H. "The Effect of Collective Bargaining on Public School Teachers' Salaries." Industrial and Labor Relations Review 24(4) (1970), 57-72.

Kasper, H. "The Effects of Collective Bargaining on the Public School Teachers' Salaries--Comment." Industrial and Labor Relations Review 25(3) (1972), 410-16.

Kenney, L., Denslow, D., & Goffman, I. "Determination of Teacher Cost Differentials Among School Districts in the State of Florida." In Selected Papers in School Finance 1975. Washington: Office of Education, U.S. Department of Health, Education, and Welfare, (1975).

Lancaster, K. J. "A New Approach to Consumer Theory." Journal of Political Economy 75 (April 1966), 132-57.

Levin, Henry M. "A Cost Effectiveness Analysis of Teacher Selection." Journal of Human Resources 5 (Winter 1970), 24-33.

Levin, Henry M. "Recruiting Teachers for Large City Schools." Unpublished monograph, Brookings Institution, (June 1968).

Levin, Henry M. "Educational Production Theory and Teacher Inputs." Stanford University mimeograph (May 1978).

Lipsky, D. B. & Drotning, J. E. "The Influence of Collective Bargaining on Teachers' Salaries in New York State." Industrial and Labor Relations Review 27(1) (1973), 18-35.

Lucas, Robert E. B. "The Distribution of Job Characteristics." Review of Economic Statistics 56 (November 1974), 530-40.

Lucas, Robert E. B. "Hedonic Price Functions." Economic Inquiry 13 (June 1975), 157-78.

Lucas, Robert E. B. "Hedonic Wage Equations and Psychic Wages in the Returns to Schooling." The American Economic Review 67(4) (September 1977), 549-58.

Lucas, Robert E. B. "Working Conditions, Wage-Rates and Human Capital: A Hedonic Study." Unpublished doctoral dissertation, M.I.T., (October 1972).

Loatman, Bruce. "A Cost-of-Education Index Methodological Considerations." Reported submitted to the National Center for Education Statistics. Arlington, Va.: Killalea Associates, Incorporated (October 1977).

Mayer, T. "The Distribution of Ability and Earnings." Review of Economics and Statistics, (May 1969), 189-95.

McFadden, D. "Conditional Logit Analysis of Qualitative Choice Behavior." In Paul Zarembka, ed., Frontiers in Econometrics, New York, (1974).

Muellbauer, J. "Household Production Theory, Quality, and the 'Hedonic Technique'." American Economic Review 64 (December 1974), 977-94.

Nutter, G. Warren & Moore, John H. "A Theory of Competition." The Journal of Law and Economics, (April 1976), 39-65.

Rosen, Sherwin. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." Journal of Political Economy 82 (January/February 1974), 34-55.

Simmons, James C. "Comments on 'Cost-of-Living Adjustments in School Finance'." Phi Delta Kappan 57 (October 1975), 120.

Thornton, R. J. "The Effects of Collective Negotiations on Teachers' Salaries." Quarterly Review of Economics and Business 11(4) (1971), 37-46.

Toder, Eric Jay. The Distribution of Public School Teachers by Race and Income Class in an Urban Metropolitan Area. Report to the Bureau of Research, Office of Education, U.S. Department of Health, Education, and Welfare. (Medford, Mass.: Tufts University, March 1971).

Tolley, George S. "The Welfare Economics of City Bigness." Journal of Urban Economics 1 (1974), 324-45.

Turnbull, D. & Williams, Gareth. "Personal Characteristics and the Earnings of Teachers: An Earnings Function Approach." Paper presented at the U.K.-U.S. Conference on Teacher Markets, University of Chicago, December 1976.

Wasserman, William. Education Price and Quantity Indexes. (Syracuse, N.Y.: Syracuse University Press, 1963).

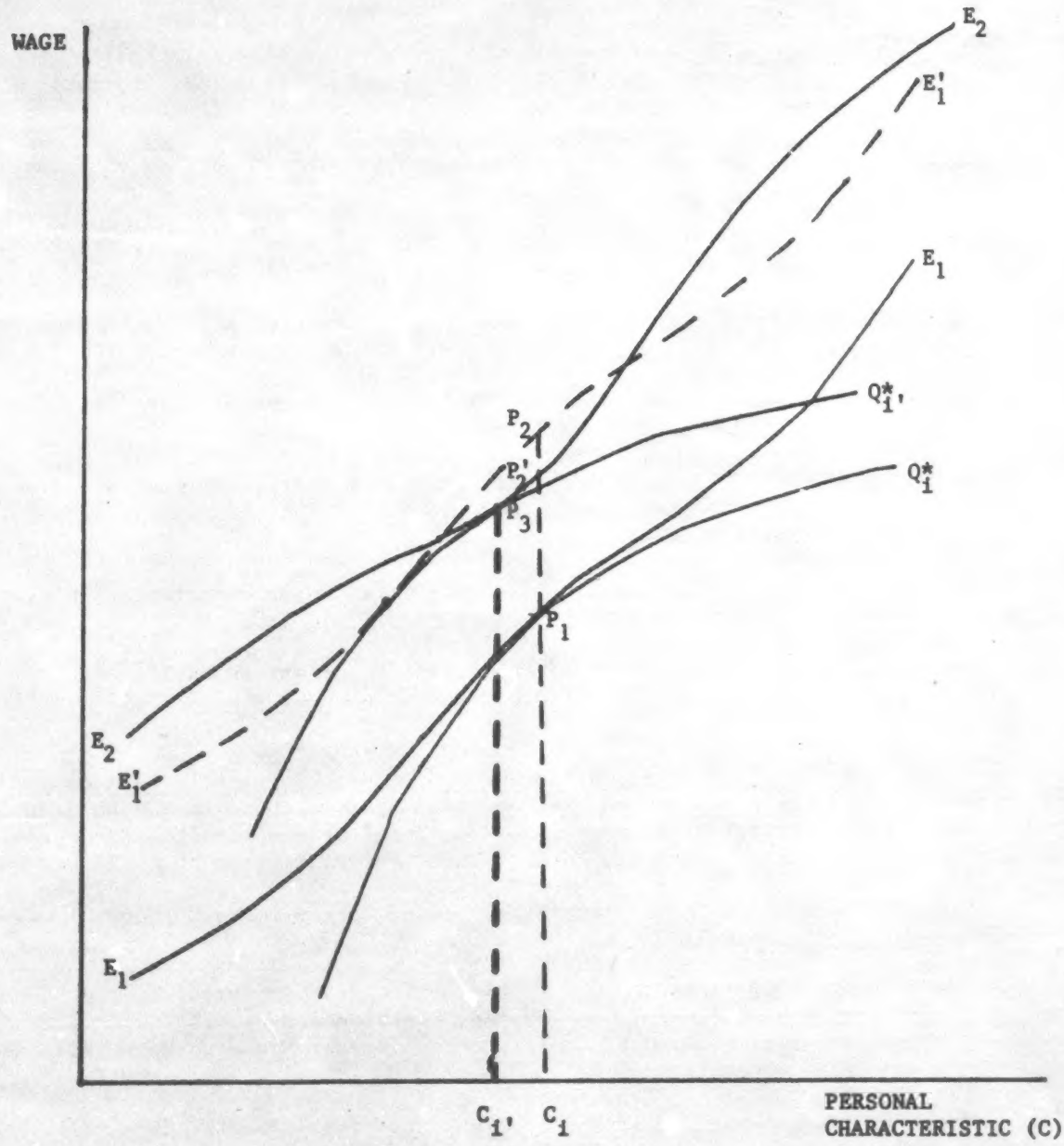
WAGE
$E_2$
$E_1'$
$E_1$
$Q_1^*$,
$Q_1^*$
$P_2$
$P_2'$
$P_3$
$P_1$
$E_2$
$E_1'$
$E_1$
$C_1'$
$C_1$
PERSONAL
CHARACTERISTIC (C)

Figure One